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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Vol. 51 No. 8

BULLETIN
OF THE
TORREY BOTANICAL CLUB

AUGUST, 1924

Studies in Tortula as represented in Southern Arizona

EDWIN B. BARTRAM

Viewed even in a restricted sense the species of Tortula from this region present some critical problems that are not lacking in interest and suggestion. The section Syntrichia, comprising a number of closely related species that have been interpreted in various ways by bryological students, is especially richly represented and I have been tempted to present some of the following conclusions, not as in any sense final but simply as a step toward a more complete understanding of this puzzling complex. The scarcity or absence of male flowers and sporophytes in several closely related species makes the result of critical study somewhat a matter of personal equation.

TORTULA MURALIS (L.) Hedw. Represented by a single collection, in fruit, from the foothills of the Catalina Mts., on the shaded face of a boulder. The lower leaves mucronate and the comal leaves with the costa excurrent into a long smooth hyaline hair point two times or more the length of the leaf. Probably a form of var. *incana* (Bry. eur.).

TORTULA INERMIS (Brid.) Mont. Common on ledges and banks in the foothills and extending up the mountain canyons to an elevation of 6500 ft. The closely folded leaves regularly spiralled with a low pitch give the dry plants a distinctive screw like aspect in the field that is very characteristic. Dozens of collections from widely separated localities are in every way uniform and indicate no transitional tendency toward *T. subulata*. The oblong ligulate, mucronate leaves with the margins strongly recurved almost to the apex are unlike anything else in the region.

[The BULLETIN for July (**51**: 283–333) was issued July 24, 1924.]

TORTULA RURALIS (L.) Ehrh. Widely distributed over the foothills and mesas, on the shaded banks of dry washes, on slightly shaded slopes or even on the open desert where it is usually sterile and depauperate. In the mountain canyons at altitudes above 4000 ft. it is usually replaced by the following.

TORTULA MONTANA (N. v. E.) Lindb. Readily distinguished from *T. ruralis*, as a rule, by the concave, hardly carinate leaves, erect spreading when moist, the less strongly recurved leaf margins and especially the smaller more obscure leaf cells in the upper part of the lamina which rarely measure over 10 μ in diameter and often only 6 to 8 μ. Some forms show a slight tendency to intergrade with *T. ruralis* in one or more characters but in this region, at least, the species surely represents a well defined segregate that replaces *T. ruralis* almost entirely in the mountain canyons.

TORTULA ALPINA (Bry. eur.) Bruch. While this plant does not seem to have been credited to the North American flora heretofore, comparisons of various collections from Arizona with authentic European material of the species, generously supplied by Mr. Holzinger and Mr. Chamberlain, indicate that *T. alpina*, in various forms, is widely scattered through the canyons and foothills of mountain ranges in the southern part of the state. In this arid country the collections from shaded ledges below 4000 ft., in the treeless foothills, are naturally xerophytic types, somewhat dwarfed and reduced in every way. As one works up the canyons into the oak belt above 4500 ft., the plants become more typical and at 6000 ft. or above, where moisture and shade are not lacking, the collections, in part at least, approach closely to the typical form of the species. The variations seem to be of degree rather than kind and present a close series of transitional forms ranging from the xerophytic types of low altitudes with reduced leaves, broadly obtuse or emarginate at the apex as in figures 12 and 13 of the accompanying plate to well developed plants of higher altitudes with larger leaves less broadly pointed, as in figure 14, which seem to closely approximate typical *T. alpina* in every essential vegetative feature. Indeed these observations lead logically to the question of whether *T. alpina* and *T. laevipila* might not better be treated as extreme forms of a single specific aggregate, modified by environment but connected by a series of transitional forms.

Exsicc:—Holz. Musc. Ac. Bor. Am. No. 500 as *Tortula pagorum.*

Bartr. Mosses of So. Arizona No. 15 as *T. pagorum.*—No. 91 and No. 95.

TORTULA ALPINA (Bry. eur.) Bruch. var. PROPAGULIFERA Limp. in Rab. Krypt. Fl. 4[1]: 683. (*Tortula pagorum* (Milde.) DeNot.; *Barbula laevipila* var. *pagorum* Husn.) The presence of characteristic propagula as figured by Limpricht, Vol. 1: 682* is the only character by which it seems possible to separate this variety from the plants referred elsewhere to *T. alpina.* In the same tuft are found plants with abundant propagula, others with only a few and still others devoid of them entirely. The dry plants with leaves folded lengthwise and tightly spirally incurved into a close head, the tendency of the hair point to become reduced to a short, more or less roughened arista, colored at the base, and the apparent preference for a rock substratum even where trees are available are all characters, which as far as the collections from this region are concerned, indicate a closer relationship to *T. alpina* than to *T. laevipila.* While the absence of any plants typical of *T. laevipila* is only a negative factor it is not without suggestion when compared with the distribution of the *T. alpina* composite over the same area.

Exsicc:—Holz. Musc. Bor. Am. No. 360 as *Tortula pagorum.*

Small Mosses of So. U. S. No. 39 as *Tortula papillosa.*

TORTULA ALPINA (Bry. eur.) Bruch. var. INERMIS (Milde.) DeNot. One of the very characteristic mosses of dry shaded, vertical rock faces in canyons of the Santa Rita Mts. and the Patagonia Mts. The plants grow in loose mats so lightly attached to the substrata that when sections are removed for specimens they seem to hang from the rock face like a curtain. The lamina structure is rather tender and fragile, much as in *T. fragilifolia* but not nearly so pronounced, the leaves are wide in the upper half with a broadly rounded apex, shortly mucronate by the excurrent red-brown costa, very similar to the outline of *T. latifolia* but always distinctly mucronate or even cuspidate. A fine moss agreeing in every essential particular with E. Bauer Musc. eur. Exsicc. No. 1595a, b from Italy also with a collection

* Limpricht's figure more closely reproduces the shape and appearance of these "brood leaves" than either figure 52, p. 86, or figure 53, p. 87, in Correns Vermehrung der Laubmoose.

by Dixon and Nicholson from Meran, S. Tyrol, Aug. 15, 1904. Apparently this is the first record from North America.

Exsicc:—Bartr. Mosses of So. Arizona No. 71 and No. 94.

TORTULA FRAGILIFOLIA sp. nov. (PLATE 7) Evidently dioicous, only sterile ♀ plants found. Plants robust, from 1 to 1.5 cm. high, branched above, strongly rufous tinged and lustrous throughout in dense cushions closely matted together with red radicles. Leaves erect spreading when moist, folded lengthwise and closely spirally incurved when dry, up to 2.5 mm. long, slightly concave, oblong spatulate to ovate oblong in outline, apex obtuse, shortly mucronate by the excurrent red-brown costa, margins narrowly recurved in the middle, distinctly crenately lobed in the upper half, torn and broken in various ways so that complete leaves are rarely if ever present; leaf cells rectangular and hyaline at the base, a well defined area of larger cells with richly colored walls in the median portion on either side of the costa bordered by a marginal band of about six rows of much smaller short rectangular cells, quickly becoming shorter and hexagonal quadrate above, 10 to 12 μ in diameter, strongly papillose on both sides with 4 to 7 large C shaped or forked papillae; costa red-brown, more or less rough and papillose on the back, in cross section showing two large median guide cells, about three smaller cells in one or two layers on the ventral side and a thick stereid band of three or more layers on the dorsal side with the outer cells little or not differentiated. Reduced branches bearing ecostate, ovate acuminate, verrucose propagula in the form of imbricated brood leaves are found sparingly in the axils of the upper stem leaves.

Type:—On bark near the base of Live Oaks along Baldy Trail, Santa Rita Mts., Santa Cruz County, Arizona. 7500 ft. E. B. Bartram No. 860. February 4, 1924.

Exsicc:—Bartr. Mosses of So. Arizona No. 87.

This plant suggests some connection with *T. alpina* var. *inermis* but the habitat on tree trunks, the dense cushions closely bound together by radicles, the very fragile structure of the lamina and the strongly crenately lobed margins would seem sufficient in the aggregate to give the plant a specific identity. It seems to be well distributed over the Santa Rita Mts. on bark near the base of oak trees above 6000 ft. but is more robust and characteristically developed at altitudes of 7500 ft. and over.

TORTULA AUREA sp. nov. (PLATE 6). Probably dioicous, male flowers not found, female flowers terminal or lateral by innovations, archegonia numerous, usually shrunken and unfertilized, with slender paraphyses. Plants robust, 1 to 2 cm. high, branched above or simple, in deep rather loose cushions, yellowish green above, light brown beneath, sparingly radiculose. Leaves spirally twisted when dry, erect spreading when moist, ovate lanceolate, tapering above to a sub-acute apex, about 2 mm. long, cuspidate by the stout excurrent costa which is occasionally prolonged into a smooth yellow hair point half as long as the leaf, margins spirally once or more revolute from base to apex; leaf cells golden yellow at the base, linear in the median portion 1 to 8 or 1 to 10, broader and shorter at the extreme base and short rectangular to quadrate toward the margins with yellowish pellucid walls, gradually shorter above, in upper half quadrate hexagonal, 10 to 12 μ in diameter, highly chlorophyllose and obscure with numerous papillae on both sides. Costa light brown, strong, about 90 μ wide from base to apex, smooth, in cross section showing two large median guide cells with one layer of about three somewhat smaller cells on the ventral side and a thick stereid band of three or more layers on the dorsal side with the outer row of cells somewhat larger.

Type:—On dry shaded ledges, Bear Canyon, Santa Catalina Mts., Pima County, Arizona. 2500 ft. E. B. Bartram No. 307. January 6, 1923.

Exsicc:—Mosses of So. Arizona No. 93.

Frequent and abundant on dry shaded ledges in the foothills of the Santa Catalina Mts. and the Tucson Mts. The absence of sporophytes leaves the relative position of this species rather uncertain but the characters in the aggregate seem to indicate a relationship to *Tortula muralis*, from any form of which it is abundantly distinct in leaf outline, spirally revolute margins and in the yellow pellucid basal areolation without any suggestion of hyaline cells.

Description of plate 6

Tortula aurea

FIGS. 1 and 2. Dry plants four-fifths natural size.
FIG. 3. Upper part of moist plant × 12.
FIGS. 4 and 5. Stem leaves × 16.
FIG. 6. Leaf apex × 40.
FIG. 7. Leaf apex × 80.
FIG. 8. One side of cross-section near middle of leaf × 240.
FIG. 9. Upper leaf cells × 240.
FIG. 10. Basal margin × 240.
FIG. 11. Median basal cells next to costa × 240.

Tortula alpina

FIG. 12. Leaf from plant growing on rubble bank in Patagonia Mts., Ariz. × 16.
FIG. 13. Leaf from plant growing on shaded ledges in Santa Catalina Mts., Ariz. × 16.
FIG. 14. Leaf from plant growing on rock face in Santa Rita Mts., Ariz. × 16.

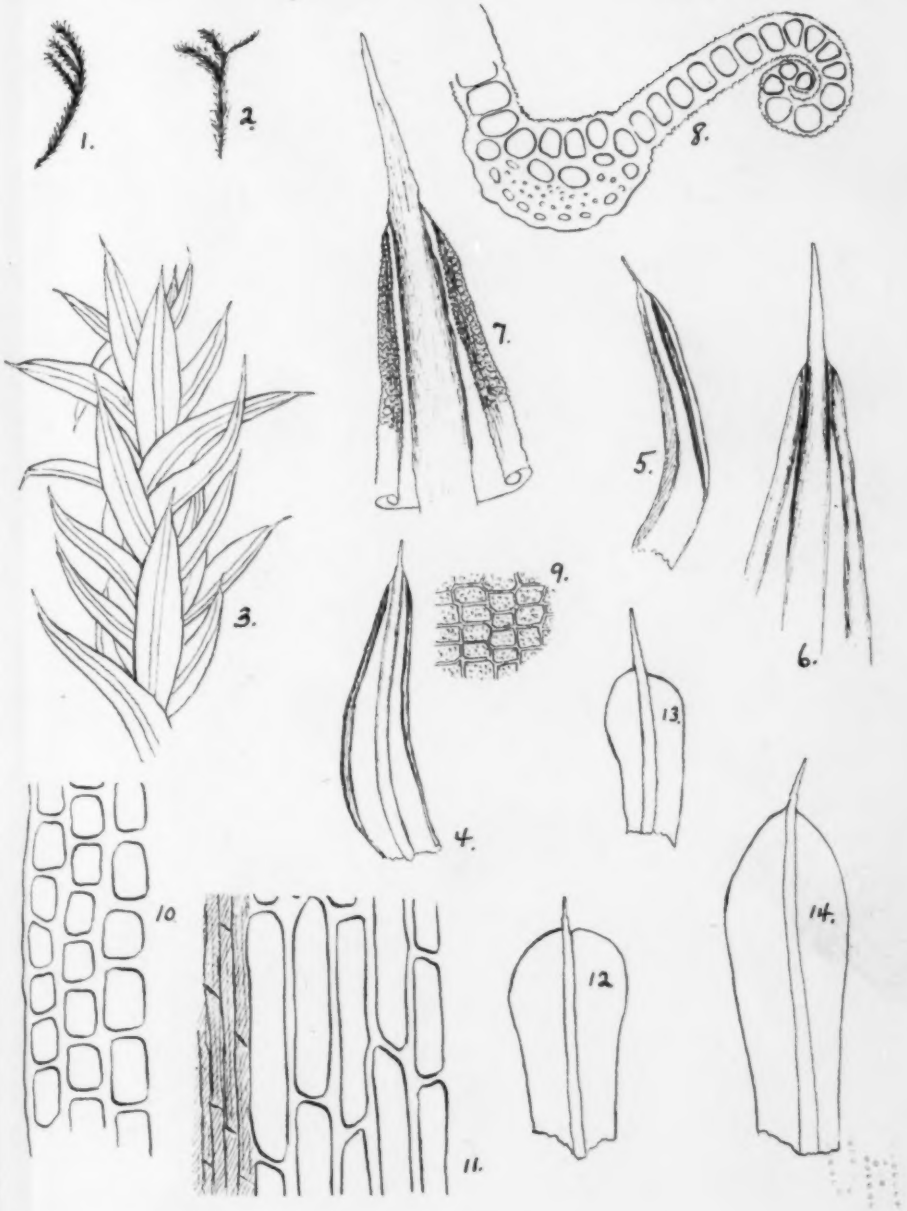
Description of plate 7

Tortula fragilifolia

FIG. 1. Moist plant four-fifths natural size.
FIG. 2. Moist plant × 4.
FIGS. 3, 4, 5, 6. Leaves × 16.
FIG. 7. Propagula × 80.
FIG. 8. Basal cells on one side of costa × 80.
FIG. 9. One side of cross-section from lower half of leaf × 240.
FIG. 10. Cross-section of costa from upper half of leaf × 240.
FIG. 11. Upper leaf cells × 480.

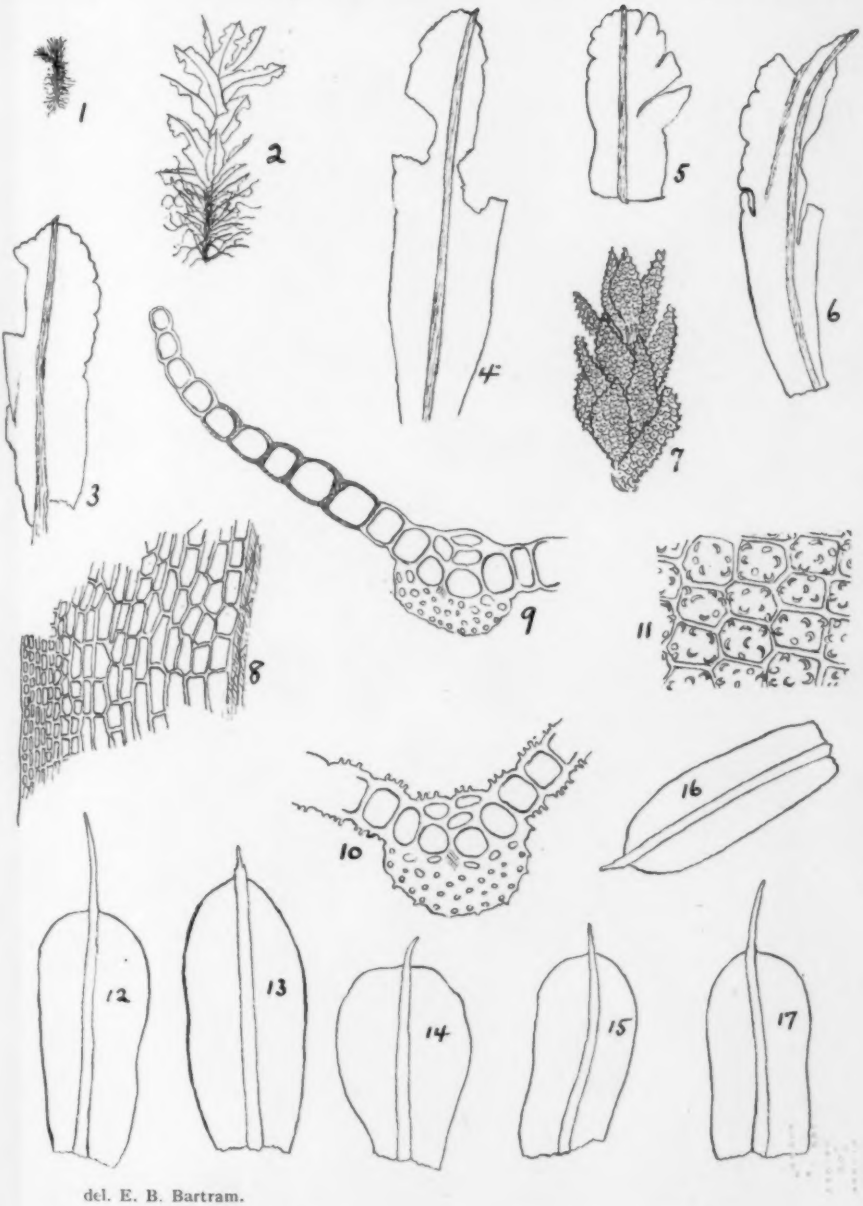
Tortula alpina var. *propagulifera*

FIG. 12. Leaf from plant growing on tree in Santa Rita Mts., Ariz., × 16.
FIG. 13. Leaf from plant growing on tree in Patagonia Mts., Ariz. × 16.
FIG. 14. Leaf from plant growing on rocks at Harpers Ferry, Va. A. T. Beals' No. 3177 × 16.
FIG. 15. Leaf from plant growing on tree, Augusta, Ga. Small Mosses of Southern U. S. No. 39 × 16.
FIG. 16. Leaf from plant growing on ledges in Patagonia Mts., Ariz. × 16.
FIG. 17. Leaf from plant growing on tree, Berkeley, Calif. Holzinger Musc. Ac. Bor. Am. No. 360 × 16.



del. E. B. Bartram.

1–11. TORTULA AUREA E. B. Bartram sp. nov.
12–14. TORTULA ALPINA (Bry. eur.) Bruch.



del. E. B. Bartram.

1–11. TORTULA FRAGILIFOLIA E. B. Bartram sp. nov.
12–17. TORTULA ALPINA var. PROPAGULIFERA Limp.

The Gregarious Flowering of the Talipot Palm, *Corypha umbraculifera*, at Peradeniya, Ceylon *

WILLIAM SEIFRIZ

The extent to which the activities of a plant are determined or influenced by the environment has long been a subject of discussion and investigation among botanists. There are those (6) who maintain that "every life process must to some degree be dependent upon the external world," while others (11) hold to the belief that many vital phenomena are innate and, within certain limits, independent of the environment.

The problem of the possible influence of environmental factors on the activities of a plant assumes an especial interest in connection with the gregarious flowering of monocarpous plants of long life cycle. There are species of bamboo which flower gregariously over large areas after 32 years of a purely vegetative life. This habit is also characteristic of the talipot palm, *Corypha umbraculifera*.

There is a popular belief, which has received some support from scientific circles, that the phenomenon of simultaneity in flowering of monocarpous plants of long life cycles is due to drought (7). The writer has collected data bearing on this hypothesis and has found little evidence to support it. Whatever effect drought may have on gregarious flowering it is relatively slight, certainly not sufficient to be regarded as the ultimate determining factor of the phenomenon. The following data, previously collected, support this point of view:

1. The simultaneous flowering throughout the mountains of Jamaica in 1918 of the climbing bamboo, *Chusquea abietifolia*, whose vegetative life extends over a period of 32 or 33 years, was preceded not by a drought but by two years of rainfall which was above the average (8).

2. The gregarious anthesis of extensive forests of the bamboos, *Dendrocalamus strictus* and *Bambusa arundinacea*, estimated to cover in some instances areas of over a thousand square miles in India, is also not always preceded by a drought (10).

* Contribution from the Osborn Botanical Laboratory, Yale University.

3. In 1918 there flowered simultaneously in the Peradeniya Gardens in Ceylon three species of monocarpic plants, *Corypha umbraculifera*, *Dendrocalamus giganteus*, and *D. strictus*, and a fourth species, *Bauhinia anguina*, which, while not monocarpic, flowers rarely. This remarkable instance of gregarious flowering was immediately preceded by a "drought" of such mildness that, when it is compared with other droughts of previous years which did not arouse the plants to anthesis, it cannot be regarded as the direct cause of this unusual simultaneous blossoming of three widely differing genera, all of which flower only after many years of purely vegetative growth.

4. At the time that the talipot palms, with other monocarpous and rarely flowering plants, were in blossom at Peradeniya, there was also in flower in the Buitenzorg Gardens in Java a talipot palm which had, every month of its life, been drenched in rain. Droughts are unheard of at Buitenzorg where even a normal dry season is a rarity (10).

5. There lives in Burma today a forest of *Bambusa polymorpha* covering hundreds of square miles, which has, since 1853, flowered sporadically in restricted and scattered areas. The forest *as a whole* has not flowered in these seventy years, although subjected to repeated droughts (10).

There is another case of gregarious anthesis which, though not in plants of monocarpic habit, has an interesting bearing on the problem of the possible effect of external environment on simultaneity in flowering. In the orchid, *Dendrobium crumenatum*, the time of the simultaneous appearance of the flowers is apparently due to a climatic influence occurring eight days in advance of the flowering. The environmental stimulus is commonly associated with, but not always accompanied by, rain (2 and 10). It is here suggested that this factor is possibly a humidity stress. High humidity may well occur without rainfall while it is always present with rainfall. It should be emphasized that it is the *time* of flowering rather than the simultaneity itself which the humidity stress determines. The *simultaneity* is due to an inherent characteristic of the orchids (10).

On the basis of the foregoing data it seems reasonable to conclude that gregarious flowering in bamboos and palms is not determined by drought but rather by a germinal factor. If an environmental complex exists which is responsible for simul-

taneous flowering, it has not yet been discovered. The following additional observations further support this conclusion.*

FIG. 1. The avenue of talipot palms in the Peradeniya Gardens, Ceylon, in December, 1920. Seven out of the twenty palms composing the avenue flowered in 1918. It will be noticed that the palm at the end of the avenue on the left is here in full foliage while in plate 8 it is in flower.

* In connection with this habit of monocarpy in long lived plants, it is of interest to note that Wieland (12) has established its presence in at least two if not six species of fossil cycads. In *Cycadeoidea Dartoni* the armour is packed with hundreds of mature cones with no trace of a succeeding foliar crown.

Among its several excellent avenues of palms, the Peradeniya Gardens in Ceylon have long had an avenue of superb specimens of the talipot palm, *Corypha umbraculifera*. The twenty palms of which this avenue formerly consisted were planted *in situ* in 1881. In June, 1918, seven of the talipots in the avenue commenced flowering and remained in blossom until the end of the year, being at their best in October–November (Fig. 1). At the same time there flowered two species of bamboo, *Dendrocalamus giganteus* and *D. strictus*, and the liane, *Bauhinia anguina*. Bauhinia had never before been seen in blossom at Peradeniya (10). It was locally suspected that the drought of January–April of that year was the cause of this remarkable case of simultaneous flowering of four species of plants all of whose flowering periods occur after many years of purely vegetative growth. In substantial support of this belief was the widespread occurrence of flowering talipots throughout Ceylon. From one observation point on the island 200 talipots were counted in flower.

When the question of the possibility of drought being the cause of the gregarious flowering of the Coryphas at Peradeniya in 1918 was discussed in a previous publication (10), it was pointed out that the remaining thirteen palms in the avenue did not flower, although of the same age and subjected to the same environmental conditions. This fact is disturbing to either hypothesis of the cause of gregarious flowering. Whether we regard the flowering as the result of an environmental stimulus, or the expression of a heritable tendency, all of the palms should have flowered simultaneously since all were of the same age and all grew in the same environment. This difficulty, however, is easily met on the basis of the hereditary hypothesis.

If a climatic factor is responsible for gregarious flowering in plants, the question arises, How long before the flowering does the stimulus occur? In the case of plants of long vegetative periods it has been suggested that the stimulus must act at least a year before flowering. If this is true, then the drought of January–April of 1918, quite aside from the fact that it was relatively mild, could not have been the cause of the flowering which followed not more than two months later. But conclusions reached on the basis of a single instance of flowering are too speculative. More convincing deductions can be formed when at least two flowerings are considered.

In June, 1922, eight more of the remaining thirteen talipot palms in the avenue at Peradeniya commenced to flower. (PLATE 8). The palms were at this time 41 years of age. The seven palms which flowered in 1918 (FIG. 1) were 37 years old. The second lot of eight Coryphas were in full flower in December, 1922. (PLATE 9.) They began to set fruit visibly in March, 1923. The fruit ripened toward the end of 1923. At the time of writing (June, 1924) the palms are still standing, but without leaves or fruit, all dead, awaiting cutting and removal.

The gregarious flowering of *Corypha umbraculifera* in the Gardens at Peradeniya in 1922 was not accompanied by any widespread flowering of this or any other monocarpic species of plant on the island.

A comparison of precipitation data preceding the flowering of the Coryphas at Peradeniya in 1918 and in 1922 should reveal the occurrence of a drought occurring at precisely the same length of time before each of the two flowering periods, if drought is the cause of the anthesis. (Should this prove to be true we should still be confronted with the problem of why the first drought aroused only seven of the palms to sexual activity, and failed to stimulate the remaining thirteen of the same age.) The precipitation data for several years preceding each of the two flowering periods is presented in the following table.*

The total annual rainfall is given for each year named. Since this total is of less significance than the amount of rain which falls during the dry season, there is also given the total rainfall for the months January–April. It is this dry season which is most likely to have a telling effect on the plants. During the remainder of the year there is usually a surplus of precipitation.

Precipitation at Peradeniya

	Jan.–Apr.	Yearly Total
Average†	17.67 inches	87.36 inches
1915	26.32	88.21
1916	18.14	81.42
1917	23.01	102.96

* The data given in this table are from Peradeniya where the palms were growing. In a previous publication, the data were from Kandy, a nearby station, where the rainfall does not differ greatly from that at Peradeniya.

† Averages are based on the data of 18 years, from 1905 to 1922.

Precipitation at Peradeniya (Cont'd)

	Jan.–Apr.	Yearly Total
1918*	13.60	94.97
1919	19.41	86.64
1920	19.41	103.06
1921	18.67	66.66
1922*	15.78	85.41

From the above table it is quite evident that drought cannot be the cause of the simultaneous flowering of seven of the talipot palms in 1918 and of eight of them in 1922. The precipitation during the dry season (Jan.–Apr.) for each of the three years preceding both flowering periods is above average. The total annual rainfall for the year immediately preceding the 1922 flowering is 21 inches below average while it is 15 inches *above* average for the corresponding year preceding the 1918 flowering. For the second year preceding each flowering the situation is reversed, and for the third year the annual rainfall is about average in both cases. The only possible basis for regarding drought as the cause of gregarious flowering in these talipots is to assume that the relatively mild droughts during the dry season of the two years of flowering—Jan.–Apr., 1918 and 1922—are the cause. This is quite improbable; first, it is very unlikely that a drought occurring but a month or two before flowering is the stimulus which starts anthesis; second, if drought is the cause one would expect it to affect all palms of the same age; and third, the two droughts in question are not deserving of the name, because the precipitation is but slightly below average.†

The belief that the dry season of 1918 had been the unfavorable factor which caused the palms, bamboos, and liane at Peradeniya to flower in that year, was supported by the extraordinary number of talipots which were to be seen in flower throughout the island. It seemed an almost unavoidable conclusion that some climatic factor of widespread occurrence

* The years of flowering.

† The absence of any rain during February was the fact which gave rise to the belief that the season, Jan.–Apr., 1918, was one of drought. Those locally interested forgot that no rain fell during February in 1916 and 1911 (and but 0.4 inches in 1912 and 1914) without causing any widespread flowering of talipots.

had brought on so extensive a flowering of these palms. In 1922, on the other hand, there was no report of a general flowering of Coryphas in Ceylon. In fact, between Colombo and Kandy no talipots were to be seen in flower.

If the anthesis of the talipots in the Peradeniya Gardens in 1922 was the result of an environmental factor this factor could not have been widely distributed because of the very restricted region of gregarious flowering among the palms on the island in that year.

Since our data do not permit the deduction that an environmental factor is the direct cause of gregarious flowering in *Corypha umbraculifera*, the only other conclusion is, that simultaneity in flowering is the expression of a heritable tendency, yet this hypothesis is not unequivocally supported by the behavior of the palms. If the age at which the palms mature sexually is fixed, one would rather expect all twenty of the palms in the avenue at Peradeniya to have flowered simultaneously since all were of the same age. The fact that they did not do this suggests, what is quite probable, that the parentage of the palms is different, and that the age of sexual maturity is not precisely the same in the offspring of different parents.*

The acceptance of the hereditary hypothesis of the cause of gregarious flowering in plants does not altogether preclude the

* It has been suggested that it is not primarily the age of Corypha which determines the time of flowering, but the height of the palm. At a certain height, which Corypha normally attains in about 34 years, the plant is unable to cope with the mechanical difficulties of maintaining a water column of that height in its vascular system. The suggestion is nicely supported by the fact that 5 shorter palms (3 clearly visible in plate 8) did not flower, either at the first period in 1918 (Fig. 1) or at the second period in 1922 (plates 8 and 9), even though of the same age as all the palms making up the avenue. (The talipot palm varies considerably in rate of growth. In the young state the peasants, including Garden coolies, habitually cut the leaves for use as umbrellas or for other purposes, so that the palm may take anything up to 20 years or more before forming a stem.) As interesting and suggestive as the above speculation is, it cannot be unqualifiedly accepted in view of the fact that it seems hardly likely that the rate of growth of 7 of the palms should be so uniform as to cause them to attain the maximum height simultaneously in 1918, while 8 of the remaining palms were equally uniform in rate of growth, being all precisely two years behind the first 7. The date of planting, it will be recalled, was precisely the same (1888) for all of the 20 palms making up the avenue.

possibility of climatic influences having a slight but appreciable effect on the *exact time* of blossoming. It is an old theory that favorable environmental conditions tend to produce purely vegetative growth while unfavorable conditions tend to bring on reproductive activity. How much truth there is in this theory it is difficult to say. What may be unfavorable for one species may have no effect on another adapted to the same general surroundings as the first. If it is true that drought is an unfavorable condition which tends to bring on reproductive activity in plants, then it is possible that as plants of long life cycle approach their normal time of flowering, the occurrence of a severe drought shortly before this time would somewhat hasten the coming of the reproductive period.

One final bit of evidence which seems to utterly preclude the possibility of drought being the primary cause of gregarious flowering in plants is, that this flowering is rhythmic in certain species. This is true in some bamboos. Thus, in *Bambusa arundinacea* three successive flowering periods in India have been recorded, making the life cycle one of 32 years (7). The flowering of *Phyllostachys puberula* is recorded in old manuscripts of China and Japan as occurring every 60 years (5). The records, somewhat incomplete, go back to the year 292 A.D.

There is little reason to doubt the fact that flowering in certain bamboos is rhythmic. There is, on the other hand, no conclusive evidence to support the presence of rhythmic changes in climate which are commensurable in length with the life cycle of certain palms and bamboos. Meteorologists are generally of the opinion that climatic cycles of some 30 or more years duration do not exist. The only approximate climatic cycle of which we can be reasonably certain is that which corresponds to the sun spot cycle. This is greatly variable, with an eleven year period and probably other periods, both shorter and longer (3). The variations which this cycle occasions are negligible, being in temperature of the order of 1° C. between extremes, and often less. The other climatic changes, such as changes of precipitation, wind velocity, and the like, which are consequences of the temperature change, are correspondingly small. That there is much evidence (for example, in growth rings of old trees) that appreciable climatic changes of many years duration have occurred within historic times, is true, but these changes do not

appear to have been rhythmic. The so-called Brückner (1) cycle of 35 years is very irregular in length, and is, apparently, confused with volcanic explosions. This cycle too, if indeed there really is such a one, is of small amplitude. Climatic changes of the geologic past are certain, but they are of irregular occurrence and of unequal duration (3), and of much too great a length to be of any interest to us here. So far as the cause of gregarious flowering is concerned the meteorologist has nothing to offer which appears to have any bearing on the problem.

Were we willing to accept the popular belief in the existence of climatic cycles,* we should still be confronted with the task of explaining why these cycles cause the talipot palm to flower in 34 years while certain bamboos reach sexual maturity in 32 years; and why the climatic cycle should cause *Chusquea abietifolia* and *Bambusa arundinacea* to reproduce every 32 years while other bamboos flower most irregularly (this seems to be generally true of many of the Philippine species).

The persistent attempt of some investigators to interpret rhythmic vital phenomenon in terms of environmental factors is apparently due, in part, to opposition to any hypothesis of behavior which dissociates the organism from its environment. But there is nothing mysterious in a rhythmic life cycle or an innate sexual periodicity. The rhythm in the flowering of talipot palms and bamboos is no more extraordinary than rhythmic sexual periods in animals, the rhythm of the life cycle of man, and the rhythmic beat of the heart. The causes are simply internal instead of external.

Conclusion.—All available evidence points towards a heritable tendency as the cause of gregarious flowering in the talipot palm, *Corypha umbraculifera*.

Acknowledgment.—The photographs published as Plates 8 and 9 are the work of Plâté, Ltd., Ceylon, and are published

* An interesting account of a popular belief in climatic cycles is the following from Francis Bacon (4). "There is a toy, which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part), that every five and thirty years the same kind and suit of years and weathers come about again; as great frosts, great wet, great drought, warm winters, summers with little heat, and the like, and they call it the prime; it is a thing I do the rather mention, because, computing backwards, I have found some concurrence."

with their permission. The writer wishes to express his indebtedness to Plâté, Ltd., for their kindness in keeping him posted on the condition of palms in the Peradeniya Gardens.

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Description of plate 8

The view down the avenue of talipot palms (*Corypha umbraculifera*) in the Peradeniya Gardens, Ceylon, in August, 1922. (Photo. by Plâté, Ltd.)

Description of plate 9

The avenue of talipot palms in the Peradeniya Gardens in August, 1922. The floral crowns of eight Coryphas can be counted. Five palms remain in foliage. (Photo. by Plâté, Ltd.)

Notes on algae of Bermuda and the Bahamas

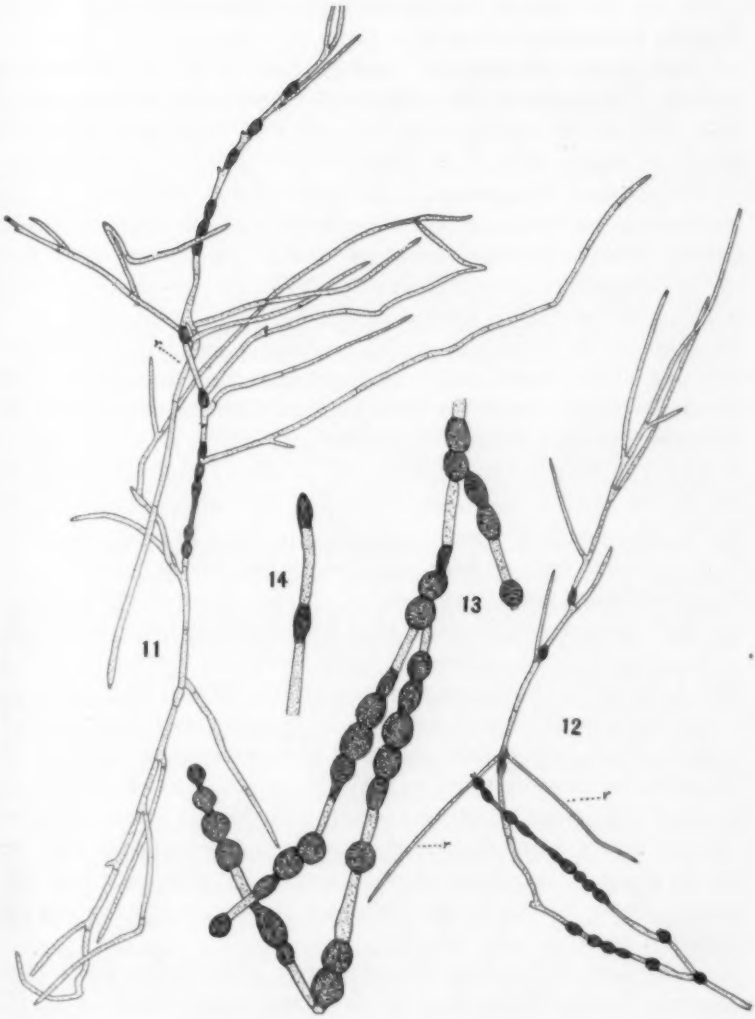
MARSHALL A. HOWE

Since the publication of the author's contributions to Britton's Flora of Bermuda (1918) and Britton and Millspaugh's The Bahama Flora (1920), further collections in Bermuda by Dr. A. B. Hervey and in the Bahamas by Mr. L. J. K. Brace and more critical studies of material previously collected have resulted in the recognition of four species that are apparently new to science, one Bermudian and three Bahamian, and in the determination of three more species not before attributed to the Bahamas. The species proposed as new are a *Pithophora* (family Cladophoraceae) from Bermuda; from the Bahamas, a *Protoderma* (?) (family Chaetophoraceae), a *Chondrocystis* (family Chroococcaceae), and a *Dichothrix* (family Rivulariaceae). The diagnoses follow:

Pithophora heterospora Howe & Hervey, sp. nov.

Filaments intricately intertangled, dark green, 1–2 cm. long, rhizoid and proximal cauloid parts often not well differentiated, the rhizoid parts occasionally developing cauloid branches and the cauloid parts sometimes emitting rhizoid branches, special haptera or helicoids not seen; main fertile cauloid filaments averaging about 56 μ (45–90 μ) in diameter, the branches commonly of one or two, occasionally of three, rarely of four and even five orders, solitary or sometimes in opposite pairs, the ultimate about 50 μ in diameter; sterile cells mostly 6–20 times as long as broad, those of the ultimate branches often 30–53 times as long as broad, the cell walls 1.5–3 μ thick; rhizoid part rarely unicellular, usually equaling and similar to the cauloid in size and ramification, the cells often somewhat more rigid and with denser content; spores (akinetes) occurring in both cauloid and rhizoid parts, mostly intercalary, occasionally terminal, those of rhizoid and proximal cauloid parts solitary, geminate, or more often 3–5, sometimes up to 10–22, in a concatenate series, polymorphic, mostly cask-shaped to subglobose and 130–182 μ × 80–143 μ, occasionally fusiform-clavate or somewhat pestle-shaped and up to 286 μ long, sometimes branched, the terminal ovoid, conic-ovoid, or ellipsoid, subacute, apiculate or subrostrate, those of median and distal cauloid parts usually intercalary and solitary or geminate, rarely in threes or fours, cask-shaped or subcylindric, mostly 156–182 μ × 68–80 μ, the occasional terminal ones bullet-shaped or conic-ellipsoid. [FIGURES 1–14.]

FIGURES 1–10. *Pithophora heterospora* Howe & Hervey. 1, a plant showing nearly all the cells of the rhizoid part converted into spores and solitary or geminate spores in the cauloid part; 2, a plant showing branches of five orders in cauloid part; 3, a fragment showing reversal of polarity or a cell of the cauloid part sending out a rhizoid branch; 4, another similar case, showing also spores of cauloid part branching or germinating *in situ;* 5–9, ends of rhizoidal filaments, showing form and arrangement of the rhizoid spores; 10, fragment of cauloid filament, showing a proliferous or germinating spore. Figures 1–3 are enlarged 11 diameters; figures 4–10, 28 diameters.



FIGURES 11–14. *Pithophora heterospora* Howe & Hervey. 11, a plant with spores in cauloid part and with one rhizoid from a median cauloid part; 12, a plant in which the basal part, with spores characteristic of rhizoid parts, has the direction of growth of the cauloid part; 13, a rhizoid part, with spores, 14, the apical portion of a cauloid branch, showing one terminal and one intercalary spore. Figures 11 and 12 are enlarged 11 diameters; figures 13 and 14, 28 diameters.

In an old cistern, on Sound Shore Road, Bermuda, *A. B. Hervey*, December, 1920; also Jan. 15, 1921.

Pithophora heterospora, though belonging to Wittrock's section "Pithophorae Heterosporeae" and more heterosporous than any of the species that he refers to that section, shows points of contact with *P. oedogonia* (Mont.) Wittr., of his section "Pithophoreae Isosporeae." It resembles *P. oedogonia* in the usual great development of the rhizoid part of the thallus and its slight differentiation from the cauloid part. In fact, with the chlorophyll content of the two parts nearly the same and with both parts producing spores in nearly equal abundance, it is sometimes difficult to assert with confidence which is the cauloid end and which the rhizoid. In distal and median cauloid parts the spores have about the same form and arrangement as in *P. oedogonia*, though smaller (156–182 μ × 68–80 μ vs. av. 230 μ × 114 μ). But in the rhizoid and proximal cauloid parts the spores are often more nearly spherical, we believe, than in any previously described species and also are often in more extended chains, in one case as many as twenty-two being counted in a single unbroken concatenate series. So far as we discover, three spores in a series are the most that have hitherto been described.

In our material, preserved with formalin, there are in the cells, lying in the protoplast or extruded from it and lying between it and the cell wall, numerous irregular or subspheric dark-colored bodies, which in the older cells and the spores take the form of flocculent or substellate flecks. We have not noted these bodies in dried specimens of other species, but do not know whether they are really characteristic of *Pithophora heterospora* or may be due to mode of preservation or to transitory physiologic conditions. These bodies do not respond to the customary microchemical tests for oil.

Pithophora heterospora is associated with *Oedogonium consociatum* Collins & Hervey, which grows epiphytically upon it, in some parts densely clothing it with young filaments or with encrusting masses of attached spores, as was the case with the type of the *O. consociatum*, which was described from Bermuda as occurring on *Pithophora kewensis* (but figured, in contradiction of the text, on *Rhizoclonium*). *Closterium moniliferum* Ehrenb. also accompanies the *Pithophora* in profuse abundance.

Protoderma (?) polyrhizum sp. nov.

Thalli light green, irregular in outline, confluent or widely continuous, closely appressed and following the irregularities of the substratum, mostly 2–10 cells thick, more or less unistratose at margins, showing frequently small ventral lobes and ridges penetrating and perhaps boring out minute cavities in the substratum; cells of the dorsal surface irregularly hexagonal or pentagonal in surface view, 10–24 μ (mostly about 14 μ) in diameter, often somewhat longer at the margins, the separating walls firm, usually 1.5–4 μ thick; cells of the interior and of the ventral surface mostly somewhat elongate vertically, often 25–45 μ long; ventral rhizoids commonly numerous, lime-boring, septate, finally more or less branched, contorted or geniculate, mostly 6–20 μ in diameter; unmodified cells of the dorsal surface becoming sporangia, these apparently of two kinds, one with very numerous and minute ovoid pallescent zoospores (?) about 1 μ long, these (in dried plants) often lying in more or less coherent mucous masses on the surface of the emptied cells, other sporangia producing larger, ovoid, ellipsoid, or fusiform aplanospores (?) 2–4 μ long.

Forming a thin almost continuous green crust on an eroded oölitic or aeolian limestone pebble in a cavern, low littoral. Malcolm Road, Caicos Islands, Dec. 19, 1907 (*Howe 5686*, type), The rhizoids spring mostly from ridges or irregular ventral thickenings that fit into grooves or cavities of the substratum and they may be wholly lacking over wide areas of the smoother parts of the ventral surface. Wille (Eng. & Prantl, Nat. Pflanzenfam. 1^2: Nachtr. 79. 1909) denies "rhizoidenartigen Verzweigungen" to the genus *Protoderma*.

As compared with specimens of *Protoderma marinum* Reinsch from Achill Sound, Ireland, distributed by Mr. A. D. Cotton, the cells of the dorsal surface of the Bahama plant are much larger and are much more firmly and regularly parenchymatous in their general arrangement; and the same holds true when comparison is made with specimens from Massachusetts distributed as *P. marinum* by Mr. F. S. Collins (Phyc. Bor.-Am. LIII), though the cells of the latter are larger than those of the Irish specimens.

Chondrocystis Bracei sp. nov.

Thallus cartilaginous or subcoriaceous, pinkish blue-green when living, more or less incrusted with lime, forming irregular expansions about 1.5 mm. broad (or broader through coalescence),

0.1–0.8 mm. thick, up to 5 mm. thick by overlapping (or falsely through corrugations), bullate, rugose, lacunose, or vesiculose, commonly somewhat hollow and bistratose, sometimes explanate or concave and more or less saucer-shaped, often with irregular ascending marginal or superficial lobes; colonies, in vegetative condition, mostly 25–80 μ in diameter, more or less polyhedral and forming a coherent pseudoparenchymatous thallus 2–10 colonies thick, or at the margins subglobose or ellipsoidal and rarely becoming free, the common wall 12–40 μ thick, cartilaginous, homogeneous or very obscurely and finely lamellate, the cells 2–64, bright blue-green to yellowish green, mostly ovoid or ellipsoid, 3–8 μ long, 3–5 μ broad, irregularly disposed or somewhat cubical or quadrangular-prismatic in arrangement, somewhat closely aggregated in a central space 20–40 μ in long diameter, the walls of subsidiary colonies and of the individual cells rather obscurely defined; colonies, in reproductive condition, subglobose, ovoid, or quadrangular-ellipsoid, 0.5–1.8 mm. in diameter, including numerous daughter-colonies of 64, 128, 256, or 512 cells, these 3–10 μ long, usually arranged in a cubical or quadrangular-prismatic fashion, but sometimes irregularly disposed, the mother colony becoming more or less hollow and thus giving rise to a similar condition in the succeeding pseudoparenchymatous small-colonied vegetative state.

Moss Hill Ponds, Long Cay, Bahamas, Dec. 15, 1905, *L. J. K. Brace 4235*,—apparently forming a crust on the margin of a brackish or salt-water pond.

Chondrocystis Bracei has points of contact with the genus *Placoma*, and in the often cubical arrangement of its cells in the "reproductive" stage or stage of most active division, it is suggestive of the genus *Eucapsis* of Clements and Schantz, described* from fresh-water plankton of Colorado. From *Placoma vesiculosa* Schousb., the type species of the genus *Placoma*, the plant apparently differs in the solidly coherent pseudoparenchymatous thallus formed by the colonies in their ordinary vegetative condition, in the absence of any radial, filamentous, or Entophysaloid arrangement of the colonies, and perhaps in the more excentric, unilateral or irregular development of the gelatinous or cartilaginous sheaths. In these characters it seems to resemble *Chondrocystis Schauinslandii*,† the mid-Pacific Ocean type of Lemmermann's genus, *Chondrocystis*, from which species it evidently differs in its foliaceous

* Minnesota Bot. Stud. **4**: 134. *pl. 20.* 1909.

† Abh. Nat. Ver. Bremen **16**: 353. 1900.

rather than cushion-like habit of growth, the larger cells, etc. In general habit, *C. Bracei* is slightly suggestive of small conditions of *Dictyosphaeria favulosa*.

Dichothrix Bornetiana sp. nov.

Filaments 16–52 μ in diameter, fascicled in erect anastomosing wick-like or penicillate clusters, terminating in short, stout, or elongate, often agglutinate, sometimes caducous hairs or merely acuminate, forming an extensive sordid-green or subfuscous turf or cespitose stratum 3–8 mm. thick and more or less encrusted with lime; branches mostly strict, appressed, or subparallel, often agglutinate; trichomes prasinous or dull yellowish-aeruginous, 8–14 μ in diameter, tapering out at apex and becoming obsolete in older parts; cells 2–8 μ (mostly 5–6 μ) long, soon obscure; sheaths 5–16 μ thick, yellowish, lamellated, the surface often rough and delaminating; heterocysts basal, solitary or geminate, elongate-ellipsoidal, 18–30 μ long.

Littoral; surrounding pneumatophores of *Avicennia nitida* and forming a turf on mud in association with *Avicennia* and *Rhizophora*.

Bahamas: Bimini Harbor, *Howe 3268*—type, April 17, 1904; Joulter's Cays, *3115* and *3116;* New Providence, *3087;* Shroud's Cay, Exuma Chain, *3949*.

Dichothrix Bornetiana is a plant that has evoked diverse opinions from phycologists who have examined it and it may continue to be a subject for a divergence of views. No less competent authorities than F. S. Collins and W. A. Setchell to whom specimens were submitted in 1908 have considered it be *Polythrix corymbosa* (Harv.) Grun., which "has burst the shell and run riot." The late Edouard Bornet, who also examined specimens, wrote under the date of April 27, 1908:

"Les nos. 3087, 3115, 3116, 3268, et 3949 me paraissent appartenir à la même espèce. Les différences d'aspect que présentent les échantillons ne sont pas plus grandes que dans d'autres espèces plus ou moins encroutées de calcaire. Les trichomes sont de même dimension, les gaines ont la même structure, elles bleuissent également par le chloroiodure de zinc; mais surtout les filaments sont réunis en faisceaux anastomosés comme on en voit dans le *Calothrix pannosa*. Cette plante, que m'est inconnue, ne se trouve ni dans la Révision, ni dans le Sylloge Algarum. J'ignore si des espèces nouvelles de *Dichothrix* marins ont été décrits récemment. Je la placerais dans le voi-

sinage des *Dichothrix cyanea* et *penicillata* dont elle est d'ailleurs bien distincte."

Dichothrix Bornetiana is occasionally mixed with small quantities of undoubted *Polythrix corymbosa* and very rarely the agglutination of filaments in a terminal fascicle may be so pronounced as to suggest *Polythrix*. It is not impossible that it does represent a condition of the *Polythrix*, yet it is preponderantly so very different from *Polythrix corymbosa* that the burden of proof would seem to rest with those who would assert identity. At least until such proof is forthcoming, it seems desirable to give the plant a distinctive name.

The trichomes and filaments are coarser, (trichomes 8–14 μ vs. 3–7 μ) and the sheaths are thicker than in *Polythrix corymbosa*, but increased development along these lines is perhaps what might be expected if the filaments of the *Polythrix* really became discrete and free. The heterocysts also are larger and often more elongate, the cells are commonly about one half as long as broad, while in *P. corymbosa* they often seem longer than broad, (perhaps on account of coalescence or imperfect definition), the trichomes are usually but not always duller or more yellowish in color, and the sheaths are commonly yellower.

Dichothrix Bornetiana is somwehat suggestive of Harvey's description and figure of *Calothrix dura* (Harv. Ner. Bor.-Am. **3**: 106. *pl. 48 D*), which Bornet and Flahault make a synonym of *Calothrix pilosa* Harv., but it has more of a *Dichothrix* habit, usually well-developed apical hairs, and no suggestion of the apical hemispheric cell or "bouton," which Bornet and Flahault have considered to be a characteristic of *Calothrix pilosa*.

In addition to *Polythrix corymbosa*, the species is sometimes associated also with *Scytonema crassum* Naeg., as determined by Bornet.

Following are three more additions to the Bahama flora:

PORPHYRIDIUM CRUENTUM (Ag.) Näg.

Growing sparsely on a small portion of a much cracked pavement, Nassau, N. P. *L. J. K. Brace* (comm. Feb. 17, 1920).

LYNGBYA LUTEA (Ag.) Gomont.

Specimens agreeing fairly well with descriptions, figures, and herbarium specimens of this species have been collected on the Berry Islands, the Exuma Chain, and Atwood (Samana)

Key. (*Howe 3640, 3986, 4162,* and *5327*), and on North Pine Cay, Andros (*Bartsch 221*). The trichomes range from 2 to 6 μ in diameter.

CHROOTHECE RICHTERIANA Hansg.

New Providence, without definite locality. *L. J. K. Brace* (comm. Sept., 1921).

NEW YORK BOTANICAL GARDEN.

INDEX TO AMERICAN BOTANICAL LITERATURE

1920–1924

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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